Nikon

# DATA COMMUNICATION BETWEEN
# *the NRK-8000/NR-5500 and a Computer*

NIKON CORPORATION

# 1. Introduction

There are three methods of transferring data from the Auto Ref Keratometer NRK-8000/Auto Refractometer NR-5500 to a Computer.

The first method is use of the Old NK Protocol which is necessary for the Auto Refractometer NR-5000. This method is possible if a communication package that allows communication with the NR-5000 is available. In this case, the communication mode should be "RS232C=NK". But in this mode, the PD value and Name can not be sent.

The second method of communication is the same as the NR-5100 has. In this mode, the PD value and Name of patients can be sent. However, KERATO datum of the NRK-8000 can not be sent. This mode is "RS232C=NNKI". This is called the "NNKI mode".

The third method can send the PD value, Name and KERATO datum. This is "RS232C=NNKE". We call it the "NNKE mode".

**Difference between NNKI and NNKE**

| | Kerato Data | Start of communication |
|---|---|---|
| NNKI | Cannot send | From external computer ···· The external computer sets DTR up. |
| NNKE | Can send | From NR(K) ···· The NR(K) sets DTR up. |

The following information explains about the different points of the second type (RS232C=NNKI) from the NR-5100, and how to transfer whole datum using the third type of communication (RS232C=NNKE).

## 2. Different Points on NNK(I, E) mode from NR-5100

It is almost the same as the NR-5100 but some Title Codes are added for the NRK-8000/ NR-5500 E.G (For some countries, codes of special characters in the free space of the heading data are different).

### Title Codes Table

| ASCII CODE (HEX) / Language | 31 | 32 | 33 | 34 |
|---|---|---|---|---|
| English (E1,E2) | MR. | MRS. | MS. | MISS |
| German (GR) | HR. | FR. | ---- | FRL. |
| French (FR) | M. | MME. | ---- | MLLE. |
| Italian (IT) | SIG. | SIG.A | ---- | SIG.NA |
| Spanish (SP) | SENOR | SRA. | ---- | SRTA. |
| Dutch (DU) | MR. | MEVR. | ---- | MEJ. |
| Danish (DM) | HR. | FRU. | ---- | FRK. |
| Swedish (SW) | HERR. | FRU. | ---- | FROKEN |
| Norwegian (NR) | HERR. | FRU. | ---- | FRØKEN |
| Turkish (TR) | BAY | ---- | BAYAN | ---- |
| Portuguese (PR) | SNR | SNRA | ---- | MNA |
| Hungarian (HN) | UR. | ASSZ. | ---- | KISA. |
| Polish (PL) | PAN | PANI | ---- | PANNA |
| Indonesia (IN) | TUAN | NYONYA | ---- | NONA |
| Greek (GK) | ΚΥΡΙΟΣ | Δ Ι Σ | ---- | ΚΥΡΙΟΙ |

***Note:*** *These Title Codes will be sent when it set in NAME INPUT MODE. And when the Title is '*', the code of Title is 30H ('0').*

### Special Character's Table

| ASCII CODE / Language | E0 | E1 | E2 | E3 | E4 | E5 | E6 | E7 | E8 | E9 | EA | EB | EC | ED | EE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GR, DU | Ä | Ö | Ü | Å | Æ | Ø | É | — | — | — | — | — | — | — | — |
| SW, DM | | | | | | | | | | | | | | | |
| NR | | | | | | | | | | | | | | | |
| GK | Γ | Δ | Θ | Λ | Ξ | Π | Σ | Φ | Ψ | Ω | — | — | — | — | — |
| HN | Á | É | Í | Ó | Ö | Ő | Ú | Ü | Ű | — | — | — | — | — | — |
| FR, PR | À | È | Ù | Á | É | Œ | Ç | Â | Ê | Î | Ô | Û | Ë | Ï | Ü |
| SP, IT | Ñ | Ç | È | Á | É | Í | Ó | Ú | — | — | — | — | — | — | — |
| TR | Ç | Ğ | İ | Ö | Ş | Ü | Á | É | Ú | Â | Ă | Ā | Í | Ő | Ű |
| PL | Ą | Ć | Ę | Ł | Ń | Ó | Ś | Ź | Ż | — | — | — | — | — | — |

## 3. Using NNKI mode

If you want to make an interface using the NNKI mode, please refer to the instructions manual entitled "On Communication between the NR-5100 and a Computer" and replace the word "NR-5100" with the "NRK-8000" or "NR-5500".

But you can't read the KERATO datum of the NRK-8000 during this procedure. So if you want to transfer the KERATO datum of the NRK-8000, you should use the NNKE mode.

## 4. How to make an interface with the NNKE mode

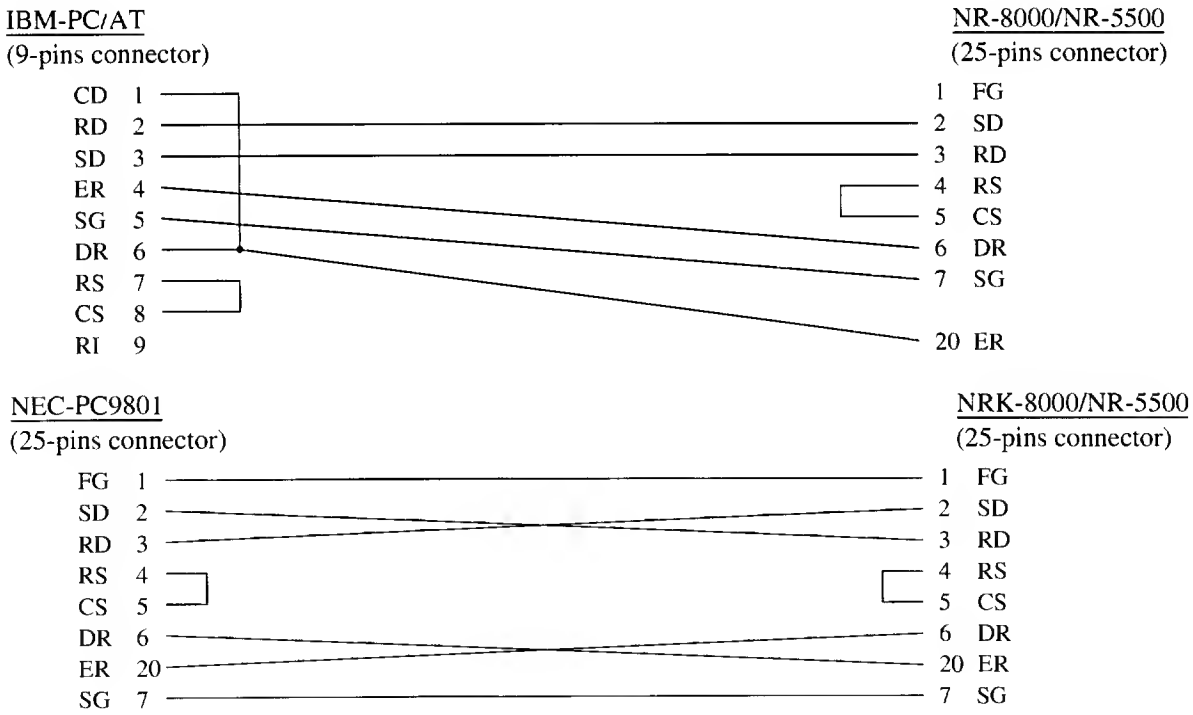
### 4.1. Preparatory procedures

- Setting up the communication port (PC)

| | |
|---|---|
| Baud Rates: | 9600 bps |
| Data Length: | 8 bits |
| Start bits: | 1 |
| Stop bits: | 2 |
| Parity: | NONE |
| XON/XOFF control: | NONE |

- Interface cable: Nikon Interface cable with NNK setting (For PC9801 only)

**Cabling**



## 4.2. Communication Procedure

A. Connecting to link the line

1. Wait until the NRK turns on its DTR line (i.e., DTR line on the PC side).
2. Turn on the DTR line on the PC side.
3. Wait until Receive [ENQ] (ENQ,BCCL,BCCH sequence (05H,05H,00H)) from the NRK.
4. Send [ACK] (ACK,BCCL,BCCH (06H,06H,00H)). This establishes a link.

B. Receiving data

After a link is established, the NRK-8000/NR-5500 sends the DATA BLOCKs (1st REF DATA. In case of the NRK-8000 only, 2nd KERATODATA).

1. Receive DATA_BLOCKs start with the Heading_BLOCK, Data_BLOCks, Last_BLOCK.

C. Releasing the communication line

1. Wait until receive [EOT] (04H,04H,00H).
2. Turn off the DTR line from the PC side.
3. Wait until the DSR is off from the PC side (i.e, DTR line of the NRK side).

## 4.3. Formats of Block

### 4.3.1. Control Characters

The following control characters are used:

| | |
|---|---|
| STX: 02H | SOH: 01H |
| ETX: 03H | ACK: 06H |
| NAK: 15H | ENQ: 05H |
| ETB: 17H | EOT: 04H |

### 4.3.2. Control Code Block

| | |
|---|---|
| [ENQ]: ENQuire | ENQ,BCCL,BCCH (05H,05H,00H) |
| [ACK]: ACKnowledge | ACK,BCCL,BCCH (06H,06H,00H) |
| [NAK]: Not AcKnowledge | NAK,BCCL,BCCH (15H,15H,00H) |
| [EOT]: End Of Transmission | EOT,BCCL,BCCH (04H,04H,00H) |

### 4.3.3. Data Block Formats

| | |
|---|---|
| A. Heading_BLOCK | SOH,Heading data,ETB,BCCL,BCCH |
| B. Ref data_BLOCKs | STX, "@RM" ,ETB,BCCL,BCCH<br>(02H,40H,52H,4DH,17H,F6H,00H) |
| | STX,refdata,ETB,BCCL,BCCH |
| | •••• |
| C. Kerato data_BLOCKs | STX, "@KM" ,ETB,BCCL,BCCH<br>(02H,40H,52H,4DH,17H,7AH,03H) |
| | STX,keratodata,ETB or ETX,BCCL,BCCH |
| | •••• |
| D. Last data_BLOCK | STX,last data,ETB or ETX,BCCL,BCCH |

A data sent from NRK consists of multiple blocks. The 1st data block contains the heading data that begins with an SOH code (format A).

The second data block contains STX, "@RM" to identify auto-ref data and subsequence blocks which contain measurement auto-ref data (format B).

In case of the NRK-8000 only, auto-kerato data will be sent, after auto-ref data is sent (format C). "@KM" is for identifying auto-kerato data.

The last data block has format D.

### 4.3.4. Block Check Code (BCCL,BCCH)

The block check code is calculated by adding together the byte value of all data characters next of the STX or SOH until the ETB or ETX.

for example:

STX, "@RM" ,ETB,BCCL,BCCH
<----------> calculation range
(02H,40H,52H,4DH,17H,F6H,00H)

40H+52H+4DH+17H=00F6H.
Consequently, BCCL=F6H, BCCH=00H.

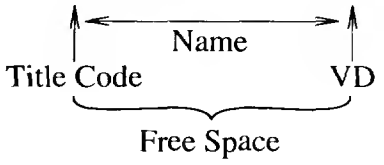
## 5. Data Format

A. Heading data

| SOH | Company Name | Model Name | ID | Date | Time | Free Space | ETB | BCCL | BCCH | |
|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (5) | (8) | (12) | (8) | (5) | (16) | (1) | (1) | (1) | length |

<Example>

SOH NIKONNRK-8000_ _ _ _ _ _ _ _ _03510/12/93_ _:_ _1Y.SMITA_ _ _ _ _ _ _2 BCCL BCCH




***Note:*** *The Free Space of NR(K) contains the title code, the name set in NAME INPUT MODE and the VD code.*
*Format of the free space is:*

| Title Code | Name | VD code | |
|---|---|---|---|
| (1) | (14) | (1) | length |

*Title Code value is between '0' – '4'.*
*Refer to the Title Codes Table in page 2.*

*VD code value is between '0' – '4'.*
*'0' 0.0*
*'1' 12.0*
*'2' 13.5*
*'3' 13.8 (13.75)*
*'4' 15.0*

B. Data identifier

| STX | @ | Data type | ETB | BCCL | BCCH |
|---|---|---|---|---|---|
| (1) | (1) | (2) | (1) | (1) | (1) |

<Example>

STX "@RM" ETB BCCL BCCH : AutoRef Data

STX "@KM" ETB BCCL BCCH : AutoKerato Data (NRK-8000 only) Receive

C. Measuring Data

After sending of the Data identifier, measurement data separated in blocks according to the data type and right and left eyes will be sent.

| STX | Data type | Eye measured | Data | ETB | BCCL | BCCH |
|---|---|---|---|---|---|---|
| (1) | (1) | (1) | ( ) | (1) | (1) | (1) |
| | ① | ② | ③ | | | |

If the data is the last one, ETB code will be replaced by ETX.

① Data type

② Eye to be measured (R or L)

③ Measurement data (items that are not measured are omitted)
The length of data depends on the Data type.

***Note:*** *The intermediate blocks are terminated by ETB.*
*The last data block is terminated by ETX.*

(1) AutoRef Data (RM)

a. Objective SPH,CYL,AX value

This means objective
SPH, CYL, AXS are value

| 0 | | SPH | CYL | AXS | ETB(X) | BCCL | BCCH |
|---|---|---|---|---|---|---|---|
| (1) | (1) | (6) | (6) | (3) | (1) | (1) | (1) |

R or L

length

b. PD value

| PD | PD value | ETB(X) | BCCL | BCCH |
|---|---|---|---|---|
| (2) | (4) | (1) | (1) | (1) |

length

<Example of AutoRef Data>

```
STX "@RM" ETB BCCL BCCH                ; AutoRef Data
STX "OR+_4.75-_2.62121" ETB BCCL BCCH  ; Right eye
STX "OL+_4.00-_0.25_69" ETB BCCL BCCH  ; Left eye
STX "PD53.0_______" ETB BCCL BCCH      ; PD value
```

(2) AutoKerato Data (KM)·····NRK-8000 only

a. Central Data R1,D1,AX1,R2,D2,AX2,Rav,CYL

| | 1 | 2 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | | | R1 | D1 | AXI | R2 | D2 | AX2 | Rav | CYL | ETB(X) | BCCL | BCCH |
| (1) | (1) | | (5) | (5) | (3) | (5) | (5) | (3) | (5) | (6) | (1) | (1) | (1) |

R or L

length

b. Peripheral Data

| | 1 | 2 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | | | H | V | T23 | N23 | S23 | I23 | Eh23 | Ev23 | Eav23 | → Continue |
| (1) | (1) | | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | length |

R or L

| → | T30 | N30 | S30 | I30 | Eh30 | Ev30 | Eav30 | ETB(X) | BCCL | BCCH |
|---|---|---|---|---|---|---|---|---|---|---|
| | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (1) | (1) | (1) |

length

***Note:*** *Figure in ( ) means number of characters. (i.e, (5) means 5 characters.)*
*23, 30 means measurement data at 23 degree, 30 degree. T, N, S, I means measurement at Temporal, Nasal, Superior, Inferior side. E is the eccentric value. v is the vertical, av is the average. So Eh30 means the eccentric value of the horizontalic at 30 degrees.*

<Example of AutoKerato Data>
STX "@KM" ETB BCCL BCCH
STX "CR_8.2341.00151_7.8243.12_61_8.02-_2.12" ETB BCCL BCCH
STX "PR_8.13_7.92._7.92_7.92_8.12_8.13_____0.0000.000 → Continue
→_7.92_7.92_8.11_8.11_____0.467 _____" ETB BCCL BCCH

## 6. Example of Data Transmission Flow for NRK-8000

An example of data transmission flow is shown.

```
==========Communication Start==========
        ==> DSR: Detect  DSR LINE TURN ON                    ← DSR CHECK
        <== DTR: TURN ON DTR LINE                            ← DTR UP
        ==> In:  Receive ENQ(05 05 00)                       ← Handshake
        <== Out: Sent    ACK(06 06 00)                       ← Handshake
Received>SOH (01)NIKONNRK-8000________03510/12/93
__:__1Y.SMITA_______2
        ==> In:  Receive ETB (17 be 0a)                      ← TXT
     01 4e 49 4b 4f 4e 4e 52 4b 2d 38 30 30 30 20 20 20 20 20 20   ← Data received
     20 20 30 33 35 31 30 2f 31 32 2f 39 33 20 20 3a 20 20 31 59      in HEX
     53 4d 49 54 41 20 20 20 20 20 20 20 32 17 be 0a
        <== Out: Sent    ACK (06 06 00)                      ← Response
Received>STX (02)@RM                                         ← Identifier RM
        ==> In:  Receive ETB (17 f6 00)
     02 40 52 4d 17 f6 00
        <== Out: Sent    ACK (06 06 00)
Received>STX (02)OR+_4.75-_2.62121
        ==> In:  Receive ETB (17 7a 03)
     02 4f 52 2b 20 34 2e 37 35 2d 20 32 2e 36 32 31 32 31 17 7a
        <== Out: Sent    ACK (06 06 00)
Received>STX (02)OL+_4.00-_0.25_69
        ==> In:  Receive ETB (17 60 03)
     02 4f 4c 2b 20 34 2e 30 30 2d 20 30 2e 32 35 20 36 39 17 60
        <== Out: Sent    ACK (06 06 00)
Received>STX (02)PD53.0________
        ==> In:  Receive ETB (17 71 02)
     02 50 44 35 33 2e 30 20 20 20 20 20 20 20 20 17 71 02
        <== Out: Sent    ACK (06 06 00)
Received>STX (02)@KM                                         ← Identifier KM
        ==> In:  Receive ETB (17 ef 00)
     02 40 4b 4d 17 ef 00
        <== Out: Sent    ACK (06 06 00)
```

```
Received>STX (02)CR_8.2341.00151_7.8243.12_61_8.02-_2.12
```
← Center, Right

```
        ==> In:  Receive ETB (17 87 01)
     02 43 52 20 38 2e 32 33 34 31 2e 30 30 31 35 31 20 37 2e 38
     34 33 2e 31 32 20 36 31 20 38 2e 30 32 2d 20 32 2e 31 32 17
     01
        <== Out: Sent    ACK (06 06 00)

Received>STX (02) PR_8.13_7.92_7.92_7.92_8.12_8.13_____0.0000.000_7.92_7.92_8.11_8.1
1_____0.467_____
```
← Peri, Right

```
        ==> In:  Receive ETB (17 b1 01)
     02 50 52 20 38 2e 31 33 20 37 2e 39 32 20 37 2e 39 32 20 37
     39 32 20 38 2e 31 32 20 38 2e 31 33 20 20 20 20 20 30 2e 30
     30 30 2e 30 30 30 20 37 2e 39 32 20 37 2e 39 32 20 38 2e 31
     20 38 2e 31 31 20 20 20 20 20 30 2e 34 36 37 20 20 20 20 20
     b1 01
        <== Out: Sent    ACK (06 06 00)

Received>STX (02)CL_8.0242.12175_8.0142.12_85_8.01_0.00
```
← Center, Left

```
        ==> In:  Receive ETB (17 72 01)
     05 05 00 02 43 4c 20 38 2e 30 32 34 32 2e 31 32 31 37 35 20
     2e 30 31 34 32 2e 31 32 20 38 35 20 38 2e 30 31 20 20 30 2e
     30 17 72 01
        <== Out: Sent    ACK (06 06 00)

Received>STX (02) PL_8.02_8.01_8.04_8.04_8.04_8.040.2090.2560.256_8.03_8.03_8.09_8.0
70.1080.2850.216
```
← Peri, Left

```
        ==> In:  Receive ETX (03 9e 01)
```
← ETX Detect

```
     02 50 4c 20 38 2e 30 32 20 38 2e 30 31 20 38 2e 30 34 20 38
     30 34 20 38 2e 30 34 20 38 2e 30 34 30 2e 32 30 39 30 2e 32
     36 30 2e 32 35 36 20 38 2e 30 33 20 38 2e 30 33 20 38 2e 30
     20 38 2e 30 37 30 2e 31 30 38 30 2e 32 38 35 30 2e 32 31 36
     9e 01
        <== Out: Sent    ACK (06 06 00)
```
← Response

```
        ==> In:  Receive EOT (04 04 00)
```
← EOT Detect

```
        <== DTR: TURN OFF DTR LINE
```
← Release

```
        ==> DSR: Detect DSR LINE TURN OFF
```
← End

```
      ====== Communication End ======
```

## 7. Flow Control Protocol Summary on NNKE mode

Transmission of measurement data is carried out in steps (a) through (e) shown below.

(a) Connecting a communication line

When sending measurement data, the NR(K) sets the DTR line (DSR on PC) on to call the PC for connection of a communication line. The PC responds by setting its DTR line on. The maximum time-out period for this response is 3 seconds.

***Note:*** *Both the NR(K) and the PC must hold their DTR off when they are not communicating. The NR(K) cannot call for the connection of a communication line if DTR of the PC is always on.*

(b) Establishing a data link

When the NR(K) recognizes the on state of its DSR (DTR of PC), it sends an ENQ control code to the PC. The PC then returns an ACK to indicate that it is ready to receive measurement data. The maximum time-out period from the time the PC receives an ENQ till it returns an ACK is 1 second.

***Note:*** *The control code ENQ referred to here is actually a three-character sequence of ENQ,BCCL,BCCH. This is also true for ACK,EOT, and other control codes.*

(c) Transmitting measurement data

When the NR(K) receives an ACK from the PC and a data link is established, it starts transmission of the measurement data. The measurement data is made up of two or more data blocks including "SOH .... ETB BCCL BCCH", "STX .... ETB BCCL BCCH" and "STX .... BCCL BCCH" sequences.

The NR(K) waits for an ACK from the PC every time it transmits one block. When the NR(K) receives an ACK response, it starts sending the next block.

The first block to be transmitted after a data link is established must begin with an SOH code. The last data block must end with an ETX BCCL BCCH. sequence.

***Note:*** *The maximum time-out period from when the PC receives a data block until it returns an ACK is 1 second.*

(d) Releasing the data link

When the NR(K) ends the transmission of the last data block and receives an ACK from the PC, it sends an EOT control code to release the data link.

(e) Disconnecting the communication line

Upon receiving the EOT code from the NR(K), the PC turns off its DTR line to disconnect the communication line. The maximum permissible response time is 1 second.

The NR(K) turns off its DTR (DSR on the PC) line after recognizing the off state of the DTR line from the PC.